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(54) Direct view liquid crystal display with automatic colour adjustment

(57) The invention relates to a direct view liquid crystal display for colored images, comprising : a LCD panel (10), a light source (16) providing approximately uniform illumination of the rear face of the panel, and color circuit means (34) for controlling the colors of the panel.

The display comprises means (32) for controlling the color control means (34) with a signal representing the intensity of the light source and/or the intensity of the ambient light. This signal controls for instance the γ correction for each color.

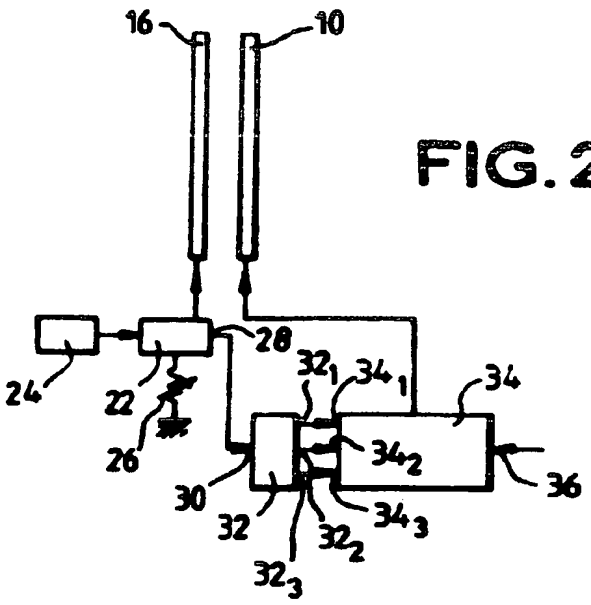

FIG. 2

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Description

The invention relates to a direct view liquid crystal display for colored images.

Liquid crystal displays (LCD) are widely used for various applications, such as Television (TV) receivers, computer displays, more particularly for portable computers called "lap top computers" and view-finders for video-cameras.

The most common displays of this type are direct view LCDs. These devices comprise generally a light source behind a LCD panel. This source is arranged to provide a uniform, or quasi-uniform, illumination of the back face of the panel, i.e. of the face which is opposite to the face which is viewed by the user.

A control element is usually provided for the manual adjustment of the intensity of the light source.

In fact it is necessary to modify this intensity when the intensity of the ambient light dies in order to obtain a good contrast of the image. The intensity of this light source must be increased (decreased) when the ambient lift intensity increases (decreases).

The invention is based on the observation that the colors of the displayed images vary with the intensity of the back source and/or with the intensity of the ambient light.

According to the invention the color control circuit of the LCD comprises means for varying the color signals in view of the intensity of the back source and/or of the ambient light.

The color control circuit is preferably provided with a control input receiving a signal represents the intensity of the back source or the intensity of the ambient light.

It will be appreciated that, with the invention, it is possible to automatically obtain always the same colors for a given image.

In an embodiment of the invention the intensity or luminance of the back source is manually or automatically controlled and the control circuit of this intensity has an output connected to the control input of the color control circuit.

In an other embodiment the control input of the color control circuit receives a signal provided by an ambient light detector.

The colors may be controlled directly or through the γ correction circuit.

It is recalled here that television signals are usually transmitted with a γ correction.

This correction takes into account the non-linear features of cathode ray tubes (CRT) : CRTs provide luminance signals which vary non-linearly with the input signals. The broadcasted γ correction is such that CRTs provide a linear response. However the response differs from one tube to the other ; therefore each tube has further γ correction means. However LCDs provide naturally a linear curve ; so they are equipped with circuits which compensate the broadcasted γ correction.

The color control circuit is arranged in such a way that it comprises three γ inputs, one for each color (red R, green G, blue B) and an interface circuit is provided with an input receiving a signal representing the intensity of the back source or of the ambient light and this interface circuit has three outputs providing γ control signals for R, G and B.

The interface is for instance a ROM (read only memory) containing a table providing, for each value of the intensity of light, the γ curves for each of the three colors.

As a display for computers is generally not intended to receive TV signals, such a display will not be equipped with a γ correction circuit. In that case the colors will be directly controlled by the intensity of light.

Other features and advantages of the invention will appear with the description of some of its embodiments, this description being made with the following drawings, in which :

- fig. 1 is a schematic drawing of a direct view color LCD,
- fig. 2 is a block diagram of one embodiment of the invention,
- fig. 3 is a block diagram of a second embodiment, and
- fig. 4 is a block diagram of a third embodiment.

Fig. 1 represents a conventionnal direct view LCD. This display comprises a liquid crystal panel 10 having a front face 12 and a rear, or back, face 14. This back face is uniformly illuminated by light provided by the combination of : a light source 16 (for instance in the shape of an elongated lamp having several branches), a diffuser 18 between the source 16 and back face 14, and a reflector 20 at the back of the source 16.

According to the embodiment of the invention shown on figure 2 the intensity of the light source 16 is controlled by an intensity control circuit, or luminance control circuit, 22 receiving power from a power supply 24 and comprising a manually operated control element 26. This element 26 determines the intensity of the light source 16.

The intensity control circuit 22 has an output 28 connected to the input 30 of an interface circuit 32 comprising three outputs 32_1, 32_2 and 32_3 which are connected, respectively, to the inputs 34_1, 34_2 and 34_3 of a circuit 34 for controlling the colors and for γ correction of panel 34.

The input 34_1 receives a signal controlling γ_R, i.e. γ for the red (R) color.

The input 34_2 and 34_3 receive, respectively, signals controlling γ_G and γ_B, i.e. γ for green (G) and blue (B).

The circuit 34 provides the color signals R, G and B to the panel 10. The circuit 34 has an input 36 receiving the video signal.

This circuit is for instance the RGB decoder/driver sold under the reference CX A 1785 AR by Sony.

In the embodiment represented on figure 3 the manual adjustment is replaced by an automatic adjustment provided by a sensor 40 connected to a control input 22_1 of the intensity control circuit 22. This sensor 40 detects the intensity of the ambient light.

In the embodiment shown on figure 4 the sensor 40 controls also the intensity of the light generated by the light source 16 ; however the colors of the LCD panel 12 are not controlled by the circuit 22 but by an interface circuit 42 which is similar to interface circuit 32 of figure 2 and figure 3.

Interface circuit 42 has, like circuit 32, an input 42_1 (which, here, receives a signal from sensor 40) and three outputs 42_2, 42_3, 42_4 connected to the respective inputs 34_1, 34_2 and 34_3 of color control circuit 34 which control γ_R, γ_G and γ_B, respectively.

In a further embodiment (not shown), which relates to a display intended for a computer, and not for TV, the signal from the luminance controller 22 or from the sensor 40 is provided to the control input of a color control circuit similar to circuit 34 of figures 2 and 3. Such color control circuit has usually a manual adjustment. In that case the signal from the luminance controller or from the sensor is provided to the input which, in coventionnal circuits, receives the signal generated by manual adjustment.

Interface circuits 32 and 42 comprise a memory of the ROM type in which data are stored as tables corresponding to curves.

More precisely the signal at the input 30, or 42_1, is, inside circuit 32 or 42, divided into a given number of value ranges. To each range corresponds a set of three curves γ_R, γ_G and γ_B.

A curve γ_R (or γ_G or γ_B) is a table providing the blue of the red signal for each quantized value of the R (or G or B) signal provided at the input 36 of color control circuit 34.

If the sensor 40 or the circuit 22 provides a nominal or average value, the color control circuit 34 will provide, through interface circuit 32 or 42, nominal values of γ_R, γ_G and γ_B for which the colors on screen 12 will appear the most actual or the most realistic for the viewer.

The tables in the circuit 32 or 42 provide a correction which maintains the colors when the intensity of ambient light or the intensity of the back source is changing.

More precisely if the intensity is decreasing the ratio of the red component of the light increases with respect to the ratios of G and B components. In that case the correction must be such that the nominal ratios be maintained. This is obtained by a decrease of the R component or by an increase of G and B components.

If the intensity of the light is increasing with respect to the nominal value, the ratio of the blue (B) component is increasing with respect to the ratios of R and G components. Therefore it is necessary to reduce the B component with respect to the other components, more particularly with respect to the red (R) component.

All the embodiments of the invention which have been described provide very simple means for controlling the colors of a liquid crystal display which do not entail a significant increase of power consumption. The quality of the image is preserved when environment conditions are changing.

In a further embodiment (not represented) an interface circuit comprises a memory of the RAM type in which is stored a set of three gamma curves γ_R, γ_G and γ_B corresponding to the present intensity of the ambient light or of the light source 16. These curves are provided by a central memory (ROM or hard disk for instance) of a computer in which are stored all γ_R, γ_G and γ_B curves corresponding to various intensities.

Claims

1. Direct view liquid crystal display for colored images, comprising a LCD panel (10), a light source (16, 20, 18) providing approximately uniform illumination of the rear face (14) of the panel, and color circuit means (34) for controlling the colors of the panel, characterized in that it comprises means (32, 42) for controlling the color control means (34) with a signal representing the intensity of the light source and/or the intensity of the ambient light.

2. A display according to claim 1, characterized in that it comprises means (22, 26) for controlling the intensity of the light source (16) and in that the signal representing the light source intensity is generated by said means (22, 26) for controlling the intensity of the light source.

3. A display according to claim 2, characterized in that the light source intensity control means comprise a manually adjustable element (26) for controlling said intensity.

4. A display according to claim 1, characterized in that it comprises a detector (40) generating a signal representing the intensity of the ambient light which is delivered to a control input (22_1) of the light source intensity control means (22)

5. A display according to any of the previous claims characterized in that the color circuit means (34) comprise a γ correction circuit and in that said means controlling this color circuit means provide a γ correction for each color, this γ correction for each color depending on the value of the signal representing the intensity of the light source and/or the intensity of the ambient light.

6. A display according to claim 5, characterized in that the means (32, 42) controlling the color circuit comprise a memory in which are stored tables representing the γ correction curves for each color at

various values of the signal representing the intensity of the light source and/or the intensity of the ambient light.

7. A display according to claim 6, characterized in that said memory is a read only memory.

8. A display according to claim 6 wherein said memory comprises a RAM memory storing the three correction curves for the present intensity of the ambient light or of the light source, these curves being provided by a central memory of a computer in which are stored all γ_R, γ_G and γ_B curves corresponding to various intensities.

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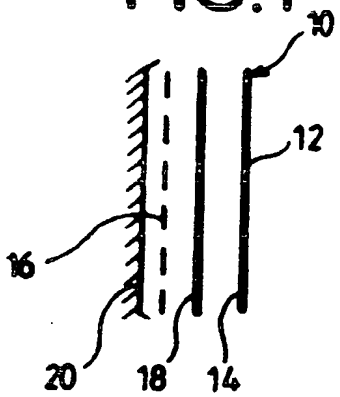
FIG.1



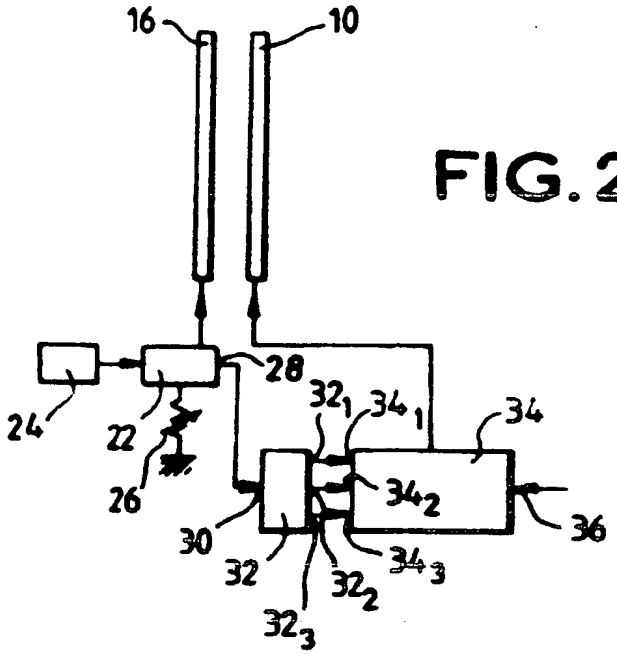


FIG.2

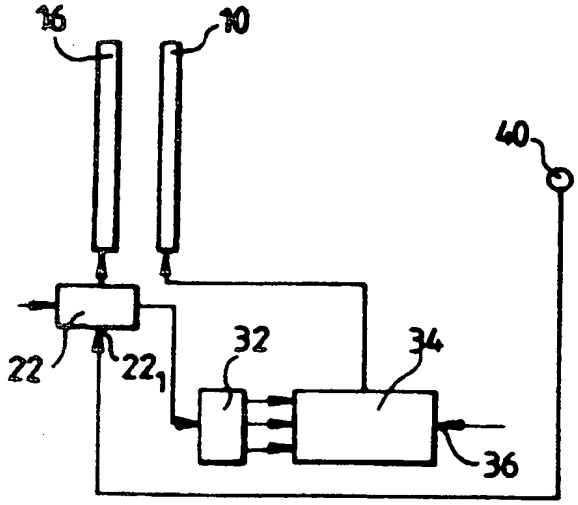


FIG.3

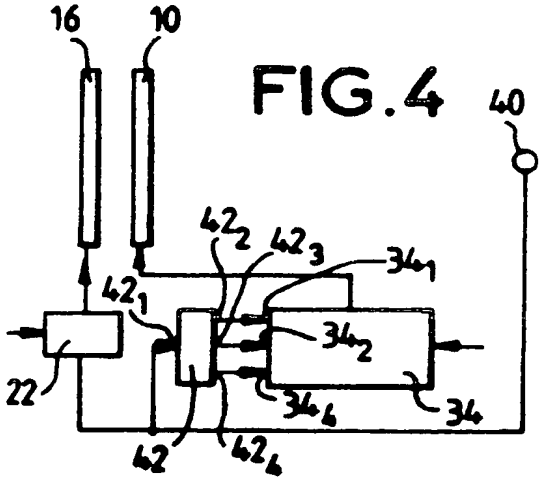


FIG.4

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EUROPEAN SEARCH REPORT

Application Number
EP 97 40 1259

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	US 5 132 825 A (S.MIYADERA) * Abstract * * column 3, line 24 - column 4, line 38; figures 3-6,11-15 * * column 5, line 28 - column 7, line 39 *	1,4	G09G3/36
Y	PATENT ABSTRACTS OF JAPAN vol. 5, no. 91 (E-061), 13 June 1981 & JP 56 035592 A (TOSHIBA CO.), 8 April 1981, * abstract *	1,4	
A	PATENT ABSTRACTS OF JAPAN vol. 96, no. 2, 29 February 1996 & JP 07 255063 A (CANON INC.), 3 October 1995, * abstract *	1,4	
A	PATENT ABSTRACTS OF JAPAN vol. 95, no. 5, 30 June 1995 & JP 07 038909 A (MATSUSHITA ELECTRIC IND. CO.), 7 February 1995, * abstract *	1,4-6	TECHNICAL FIELDS SEARCHED (Int.Cl.6) G09G
A	US 5 406 305 A (SHIMOMURA ET AL.) * Abstract * * column 4, line 4 - column 5, line 8 *	1-4	
A	EP 0 735 520 A (SHARP K.K.) * Abstract * * column 7, line 47 - column 9, line 45; figures 1-4E,10 *	2,3,5	
A	US 4 394 688 A (IIDA ET AL.) * Abstract * * column 3, line 32 - column 4, line 66; figure 1 *	2,3,5-8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 October 1997	Corsi, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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